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IN THE
Supreme Court of the United States

SOLID WASTE AGENCY OF NORTHERN COOK COUNTY,
Petitioner,

v.

UNITED STATES ARMY CORPS OF ENGINEERS, *et al.*,
Respondents.

On Writ of Certiorari to the United States Court of Appeals for the Seventh Circuit

BRIEF OF DR. GENE LIKENS, DR. JOY ZEDLER, DR. BILL MITSCH, DR. REBECCA SHARITZ, DR. JOSEPH LARSON, DR. LEIGH FREDRICKSON, DR. MARK BRINSON, DR. ORIE LOUCKS, DR. STUART PIMM, DR. RAYMOND SEMLITSCH DR. CURTIS BOHLEN, DR. CHRISTOPHER WOLTEMADE, DR MICHAEL HIRSCHFELD, DR. JOHN CALLAWAY, DR. TERRY HUFFMAN, DR. TOM BANCROFT, DR. KLAUS RICHTER, DR. JOHN TEAL, AND THE ASSOCIATION OF STATE WETLAND MANAGERS AS AMICI CURIAE IN SUPPORT OF RESPONDENT

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STATEMENT OF INTEREST

Pursuant to Supreme Court Rule 37, we file this brief with the consent of the parties as amici curiae in support of Respondent, the United States.[1]

Amici are distinguished scientists with broad expertise in America's aquatic ecosystems. Amici also include the Association of State Wetland Managers, this country's professional society of state and local government scientists and scientists in the private sector involved with the protection, study, or mitigation of wetlands. Scientists authoring this brief include members of the National Academy of Sciences or its science review boards, leading authors on wetlands, hydrology, migratory birds, amphibians, and conservation biology. Amici include many scientists who have served on panels of the National Academy of Sciences established to advise Congress or federal agencies on issues related to wetlands. An appendix with a brief biography of each scientist is attached.

SUMMARY OF ARGUMENT

The essential issue in this case is whether the Clean Water Act and Commerce Clause permit regulation of discharges into "isolated" water bodies. Petitioner argues that isolated waters lack the important functions of adjacent wetlands that justified their inclusion as "waters of the United States" in *United States v. Riverside Bayview Homes, Inc.*, 474 U.S. 121 (1985). Science indicates that

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[1] This brief was not authored in whole or in part by counsel for a party, and no person or entity, other than amici curiae or their counsel, made a monetary contribution to the preparation or submission of the brief. The Director of the Association of State Wetland Managers, however, shared a draft of the brief with an attorney for the Environmental Protection Agency, who provided some suggestions on language that probably influenced a few sentences of the brief.

Petitioner's assertion is incorrect. Isolated waters perform precisely the same water quality, flood protection, and other hydrologic and biological functions highlighted by this Court in that case. Indeed, even if Petitioner is correct that "waters of the United States" can only encompass waters that are "closely related" to traditional navigable waters, isolated waters have the same close relationship as the adjacent wetlands at issue in *Riverside Bayview Homes*.

So-called isolated ponds and wetlands (often isolated only as a matter of degree) provide a basic function that wetlands adjacent to navigable waters and their tributaries provide – they store water. If they are left unaltered, the water they store is used by plants, evaporates, or filters through them and often reaches streams and rivers through groundwater. But when isolated ponds and wetlands are developed and drained, the water and its associated pollutants are typically transported quickly and without filtration into the local streams which feed into larger, ultimately navigable, downstream rivers, lakes, and coastal waters.

The results can be severe. Streams receive rapid influxes of water and associated pollutants they had not previously experienced. This may cause flooding, severe bank erosion, and downstream water quality problems. Furthermore, the untrapped water that now flows rapidly as runoff into streams during the spring rainy season is no longer available to recharge groundwater and provide the critical "base" flow to streams in drier summer months.

Indeed, isolated water bodies are often connected to streams and rivers precisely in the same way as the groundwater-fed wetlands at issue in *Riverside Bayview Homes* – through groundwater. The difference is the relative proximity of the wetlands at issue in *Riverside*

Bayview Homes, a difference that does not speak to the basic functions described by this Court in that case.

Petitioners also dismiss the "biological" relationships between isolated ponds and wetlands and navigable waters as an alleged secondary consideration in *Riverside Bayview Homes* that should not be allowed to usurp land use functions through the unjustified regulation of "minuscule" areas in people's backyards.

In fact, the inclusion of "isolated water bodies" does not dramatically alter the reach of the Clean Water Act beyond areas Petitioner finds acceptable. Isolated wetlands probably occupy less than 20% of all wetland acres. Despite this limited extent, isolated waters are critical to the "biological" integrity of aquatic ecosystems because they play a distinct role in the life cycle of many aquatic species, including those which travel across state boundaries and which use navigable waters at other life stages. Most ducks in the United States breed in isolated wetlands and ponds, as do perhaps half of all amphibians, but they also use navigable rivers and coastal waters in non-breeding seasons. Migrating wading birds, like the great blue herons in this case, also rely heavily on isolated ponds and wetlands for breeding or other critical life stages. Unless isolated water bodies are preserved, the ecosystems of major rivers, lakes and coastal waters cannot be preserved as we know them.

This case illustrates these critical linkages. The ponds and wetlands provide an important breeding area for great blue herons, which also use major rivers. The record further reveals many potential hydrologic effects from the development of the ponds. One reason the Army Corps of Engineers denied the permit was that Petitioner failed to demonstrate properly what it would do to dispose of the water after development – water that would otherwise reside in the ponds at depths up to thirteen feet. The Army Corps'

final permit decision does not discuss all the downstream potential consequences of this problem. But given the location of the ponds less than two miles from the Fox River, it seems likely that filling these ponds without proper precautions could result in some of the water and associated pollutants finding their way to the Fox River and from it down the Illinois and Mississippi Rivers. The Corps of Engineers also denied the permit because it found that the proposed landfill would pose an unacceptable risk of contamination to a critical drinking water aquifer.

ARGUMENT

All parties in this case agree that the Clean Water Act and the Commerce Clause appropriately authorize protection as "waters of the United States" of any stream, wetland, or pond that flows directly or indirectly into traditionally navigable waters. Petitioner, the Solid Waste Agency of Northern Cook County ("SWANCC"), agrees that this statutory conclusion follows from *United States v. Riverside Bayview Homes, Inc.*, 474 U.S. 121 (1985). It held that "adjacent wetlands" are appropriately defined as waters of the United States because of their hydrologic and biological importance to other water bodies. Although Petitioner focuses much of its argument on the Act's use of the term "navigable waters," it concedes that any water body that ultimately flows into a navigable water can be protected regardless of the significance for navigation itself because the water quality goals of the Clean Water Act make it reasonable to address pollution at its source.

Petitioner also accepts the view that any tributary water body and adjacent wetland can be legitimately regulated under the Commerce Clause. Although this water quality relationship may have no effect on navigation, Petitioner claims that interpreting the Clean Water Act with this limitation is sufficient to avoid a serious constitutional

question. Brief for the Petitioner at 26-28. Petitioner never explains the source of this Commerce Clause authority, but Petitioner presumably supports this Court's prior decision that the Commerce Clause permits Congress to regulate activities that have environmental effects in more than one state. *Hodel v. Virginia Surface Mining and Reclamation Association,* 452 U.S. 264, 282 (1981) ("[W]e agree with the lower federal courts that have uniformly found the power conferred by the Commerce Clause broad enough to permit congressional regulation of air or water pollution, or other environmental hazards that may have effects in more than one State.").

Both Petitioner's statutory and constitutional argument in this case therefore rely heavily on a factual premise: that isolated water bodies lack hydrologic significance for downstream, navigable water bodies. As explained in this brief, this premise is not valid, even as a matter of degree because isolated water bodies store water, and keep it and its associated pollutants from flowing downstream.

Petitioner also downplays the biological role of isolated water bodies as a secondary concern of the Clean Water Act. It also claims that regulation of isolated water bodies leads to unacceptable intrusions on local land use authority in conflict with the limitations of the Commerce Clause. This argument too has a major empirical dimension, for in weighing the practical implications of a potential ruling, this Court will presumably want to weigh the importance of isolated water bodies to the biological goals of the Clean Water Act against the degree to which their protection expands the reach of that Act. But this case is not about the miniscule spot in the backyard (although wetlands can be in backyards). Isolated water bodies can be hundreds of acres and relatively deep and can provide most of the aquatic habitat in a few regions. Their biological value is closely related even to navigable waters because they

provide distinctly kinds of habitats critical for water birds and other aquatic animals at certain seasons or life stages even though these animals use truly navigable waters at other times.

A. Hydrologic Functions of Isolated Water Bodies

In *United States v. Riverside Bayview Homes, Inc.*, this Court considered whether it was permissible for the Corps of Engineers to regulate wetlands adjacent to a lake in Michigan when the wetlands' only connection to the lake was through groundwater. This Court noted "the evident breadth of congressional concern for protection of water quality and aquatic ecosystems," 474 U.S. at 133, and "the inherent difficulties of defining precise bounds to regulable waters." 474 U.S. at 134. In such a context, this Court held the regulation of such wetlands was justified because of "the Corps' ecological judgment about the relationship between waters and their adjacent wetlands."

Hydrologic functions provided one part of this relationship. This Court noted:

> For example, wetlands that are not flooded by adjacent waters may still tend to drain into those waters. In such circumstances, the Corps has concluded that wetlands may serve to filter and purify water draining into adjacent bodies of water, and to slow the flow of surface runoff into lakes, rivers, and streams thus preventing flooding and erosion.

474 U.S. at 134. This precise statement is equally true of "isolated" ponds and lakes.

The term "isolated" wetland or pond is not a precise, scientific (or even regulatory) term. In general, the term is used loosely to define wetlands or ponds that lack a surface outlet to downstream rivers and bays. Such wetlands and

ponds typically form in depressions in the landscape and are "isolated" because the higher elevation of the land around them keeps water from flowing further downhill and downstream through even small rivulets. Like wetlands generally, their hydrology is complex and varied, but also like all other water bodies, they have two potential sources of water. First, they typically receive the rainfall or snow melt that runs off a local watershed. This watershed can include millions of acres, as in the case of the Great Salt Lake, which is also an isolated water body, or only a few acres, in the case of small wetlands. Second, they may be fed by groundwater. In many cases, groundwater itself moves downhill across the landscape at various depths below ground but intersects the surface where the surface dips and forms a low depression. Often this groundwater flows through the wetland or pond and then continues underground toward a stream.[2]

As this statement implies, this Court should recognize that "isolated" is generally a matter of degree and for this reason there is no accepted scientific definition of "isolated" ponds or wetland.[3] Many ponds and wetlands overflow into small streams during extremely wet periods. And like the precise groundwater-fed wetlands at issue in *Riverside Bayview Homes*, many otherwise "isolated" wetlands and

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[2] For a discussion of the hydrologic conditions that form wetlands and their interactions with groundwater, see Thomas Winter, Judson Harvey, O. Lehn Franke & William Alley, Ground Water and Surface Water: A Single Resource, U.S. Geological Survey Circular 1139, at 19-21, 46-47 (1999).

[3] Because wetland scientists do not usually use the term "isolated wetlands," the scientific literature cited in this brief regarding isolated wetlands usually refers to depressional wetlands or discusses specific wetland systems, such as prairie potholes, pocosins, playa lakes or Delmarva Bays, that are the typical examples of isolated wetlands.

ponds also have important, and sometimes quite direct, groundwater connections to streams, rivers or bays. *Id.*

Regardless, it is not only the degree to which so-called "isolated" wetlands and ponds are in fact connected to streams that determines their hydrologic functions; it is just as much their degree of isolation. *The basic function served by "isolated" ponds and wetlands is simply that they store water at least temporarily, often filter it through their plans and soils, and keep it from flowing further downhill and downstream over the surface.*[4] Conversely, in the typical case, the discharge of dredge or fill material in isolated wetlands and ponds displaces at least some of this storage and typically requires draining this water away and redirecting it into local streams and from there further downstream.[5] This prolonged storage of water is the same

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[4] Winter, *et al.*, *supra* note 2, at 46 ("[M]any areas of glacial and dune terrain do not contribute runoff to an integrated surface drainage network. Instead, surface runoff from precipitation falling on the landscape accumulates in depressions, commonly resulting in the presence of lakes and wetlands."). V. Carter, *Technical Aspects of Wetlands: Wetland Hydrology, Water Quality and Associated Functions*, in J.D. Fretwell, J.S. Williams, P.J. Redman (eds), National Water Summary on Wetland Resources, U.S. Geological Survey Water-Supply Paper 2425 (1996) ("In drainage basins with flat terrain that contains many depressions (for example, the prairie potholes and playa lake regions), lakes and wetlands store large volumes of snowmelt and (or) runoff. These wetlands have no natural outlets, and therefore this water is retained and does not contribute to local or regional flooding.")

[5] "The withdrawal of shallow basin wetlands [in the central regions of the U.S.] through ditching and drainage has greatly increased the rate at which water is discharged from the upland landscape into the remaining wetlands, streams and floodplains. . . . The presence of the drainage channel system increases the flood peak and greatly increases the potential for transport of substances into the aquatic environment." O.L. Loucks, *Restoration of the Pulse Control Function of Wetlands and Its Relationship to Water Quality Objectives*, in Jon A. Kusler & Mary E. Kentula (eds), Wetland Creation and Restoration: The Status

fundamental characteristic that gives adjacent wetlands their hydrologic functions and explains why isolated ponds and wetlands are also important to the functions of flood control, water quality filtration, and streambank erosion highlighted in *Riverside Bayview Homes*.

For example, most of North and South Dakota and much of Iowa and Minnesota form the prairie pothole region of rolling hills and depressional basins. Rain and melting snow flows from the hills into the basins, where it is trapped, and therefore kept from flowing downstream. For example, the Devils Lake basin of North Dakota is already a highly floodprone area, but one study of the basin found that potholes store about 72% of the total runoff in the largest storm that occurred every two years and about 41% of the storm expected to occur once every 100 years.[6] Similarly, an analysis for a federal interagency task force, formed in response to the midwest floods of 1993, found that the most effective area for restoring wetlands to reduce flood damages downstream would be in watersheds with prairie potholes because of their closed nature.[7]

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of the Science 56 (1990). The discharge of dredge or fill material in isolated wetlands or ponds typically occurs during the construction of drainage ditches, and in any event, typically occurs for agricultural purposes, or for developing houses, highways, or facilities like landfills, where the economic use requires associated drainage. Filling wetlands also has the effect of displacing all or at least some of the storage capacity of a wetland, typically forcing the water to go somewhere else (usually through the associated drainage devices).

[6] A.P. Ludden, D.L. Frink & D.H. Johnson, *Water Storage Capacity of Natural Wetland Depressions in the Devils Lake Basin of North Dakota*, 38 J. Soil & Water Cons. 45-48 (1983).

[7] Interagency Floodplain Management Review Committee, Sharing the Challenge: Floodplain Management Into the 21st Century 46-47 (1994).

Today roughly two-thirds of the original 15 to 17 million acres of prairie potholes have been developed, primarily for agriculture, and the water is now drained in elaborate systems of tile drains and drainage ditches into flowing streams.[8] Several studies conclude that this development contributes to flooding and flood damages along the Red River of North Dakota and in sections of Minnesota and Iowa.[9] Studies in other kinds of landscapes have also shown that drainage of such isolated wetlands increases peak flows downstream.[10]

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[8] Council on Environmental Quality, Environmental Trends 102 (1989).

[9] L.J. Brun, J.L. Richardson, J.W. Enz & J.K. Larsen, *Stream Flow Changes in the Southern Red River Valley*, 38 *N.D. Farm Res.* 1-14 (1981) (increased stream flows in the southern Red River were significantly correlated with increase in drainage in each subbasin); K.L. Campbell & H.P. Johnson, *Hydrologic Simulation of Watersheds with Artificial Drainage*, 11 Water Resources 120-26 (1975) (finding that complete drainage of isolated depressions in Iowa would result in greatly increased flood peak flows); I.D. Moore & C.L. Larson, *Effects of Drainage Projects on Surface Runoff from Small Depressional Watersheds in the North-Central Region*, Water Res. Cent. Bull. 99 (1979) (drainage of isolated wetlands resulted in increased storm volumes and peak discharges from average annual flows). These and other studies are discussed in T.C. Winter, *Hydrologic Studies of Wetlands in the Northern Prairie*, in Arnold Van der Valk (ed.), Northern Prairie Wetlands (1989). A similar summary with a few additional studies is included in Daniel E. Hubbard, Glaciated Prairie Wetland Functions and Values: A Synthesis of the Literature, U.S. Fish & Wildlife Service Biological Rep. 88(43), at 14-16 (1988).

[10] *See* R.W. Skaggs, J.W. Gilliam, T.J. Sheets & J.S. Barnes, Effect of Agricultural Land Development on Drainage Waters in the North Carolina Tidewater Region, Water Resources Research Institute Report No. 159 (1980) (showing three to four times increased peak runoff rates in agriculturally developed versus undeveloped wetland soils in Eastern North Carolina). (Although this study does not use the term "isolated wetlands," the areas discussed in North Carolina are often considered isolated; *see* Council on Environmental Quality, *supra* note 8, at 103.) *See also* Loucks, *supra* note 5, at 56 (summarizing studies of a watershed around Madison, Wisconsin, showing drainage of depressional wetlands, along with other wetlands, contributed to increased peak flows).

By contributing to larger flows downstream, the drainage of isolated ponds and wetlands also contributes to the erosion of streambanks by increasing the frequency of high flows.[11] Streambank erosion is a major problem in agricultural regions of the Upper Midwest, and contributes significantly to sediment water quality problems in downstream rivers, including navigable water bodies.[12]

The development of isolated ponds and wetlands also has other water quality impacts. The reason is that the pollutants that were filtered by or stored in the wetland are moved directly into neighboring streams and eventually the rivers and bays they feed.

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[11] The relationship between more rapid drainage and flow and streambank erosion, acknowledged by this Court in Riverside Bayview Homes, 474 U.S. at 134, has long been known to scientists. M.G. Wolman & J.F. Miller, *Magnitude and Frequency of Forces in Geomorphic Processes*, 68 J. of Geology 54-74 (1960), discusses that it is bankfull flows that typically occur on average once every year or two that have the greatest effect, and these are the kinds of increased flows some studies have associated with drainage of isolated wetlands, *see supra* note 9.

[12] The State of Illinois's action plan for the Illinois River focuses significantly on streambank erosion caused by increased flows from alteration of the landscape (which includes the drainage of isolated wetlands). The State of Illinois's Integrated Management Plan for the Illinois River Watershed (1997) describes how sedimentation, caused in part by streambank erosion, is filling up backwater lakes on the Illinois River and creating problems for navigation. Discussing how "swiftly moving waters" due to alterations of the landscape, are "carving away at streambanks," the plan includes seven features to slow down the flow of water to reduce stream erosion.

Because there is no inherent reason to distinguish the water quality effects of isolated wetlands from those of other kinds of wetlands, few studies attempt to do so. But studies that directly measure the transformation of pollutants in the occasional overflow from isolated wetlands types, or studies of watersheds with a high proportion of isolated wetlands, support the view that their water quality functions are significant. For example, studies have shown that prairie potholes significantly reduce concentrations of pollutants in agricultural runoff, and conversely, a study in the prairie pothole region of northwestern Iowa has shown that pollution concentrations increase as wetland acreage is decreased by drainage.[13] The U.S. Geological Survey has also shown that on the Delmarva Peninsula (the eastern shore of the Chesapeake Bay), the concentrations of nitrate, a major pollutant of concern, decrease in correlation with the presence of forested wetlands, many of which are in isolated "closed depressions."[14] Other studies have reached similar conclusions.[15]

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[13] *See e.g.*, Hubbard, *supra* note 9 at 17-18 (discussing study that found Iowa prairie blocked all runoff in dry years and removed more than 75% of nitrogen in wet years when they had outflow); R.K. Neely & J.L. Baker J.R. Jones, V.P. Borofka & R.W. Bachman, *Factors Affecting Nutrient Loads in Some Iowa Streams*, 10 Water Research 117-121, at 120-121 (1976) (discussing increase in nutrient loads in streams with watersheds with fewer wetlands and more drainage).

[14] P. J. Phillips, J. M. Denver, R. J. Shedlock & P.A. Hamilton, *Effect of Forested Wetlands on Nitrate Concentrations in Ground Water and Surface Water on the Delmarva Peninsula*, 13 Wetlands 75-83 (1993).

[15] For studies in other watersheds, see Loucks, *supra* note 5, at 58 (summarizing series of studies showing that drainage of depressional wetlands resulted not only in increased peak flows but also in increased nitrogen and phosphorus concentrations to a downstream lake). *See also* R.W. Laney, *The Elimination of Isolated and Limited-Flow Wetlands in North Carolina*, Proceedings of the Symposium on Coastal

The development and drainage of isolated wetlands, as with other wetlands, can actually reverse water quality effects by releasing long trapped pollutants. Many wetlands trap toxic pollutants, such as mercury, lead, and PCBs in wetland soils where they are immobilized. When these wetland soils are excavated and placed alongside drainage ditches, the toxicants may be released from their bound form into the water where they can move downstream and cause harm to animal life and humans.[16]

Perhaps most simply, while the facts of this case involve the discharge of dredge or fill material under Section 404 of the Clean Water Act, this Court's decision will have equal significance for Section 402 of the Act, which regulates the discharge of other wastes. (All regulation under the Clean Water Act is tied to the definition of the term "discharge," which incorporates the term "navigable waters." *See* 33 U.S.C. Sec. 1362(12)). If regulation of isolated water bodies is impermissible, then the federal government equally cannot regulate the discharge of industrial waste or sewage into isolated lakes and ponds. Because of the many different ways in which water in isolated ponds and wetlands can reach flowing streams, any discharge of waste itself into these water bodies risks of contamination of these streams and downstream rivers as well.

Finally, many isolated wetlands affect water quality by holding water back during wet seasons and feeding the water slowly to streams and rivers through groundwater during the drier months of the year. This water is called

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Water Resources, American Water Resources Association (1988) (making similar finding in North Carolina).

[16] Office of Technology Assessment, U.S. Congress, Wetlands: Their Use and Regulation, 48-52 (1984); R.P. Gambrell, *Trace and Toxic Metals in Wetlands - A Review*, 23 J. Env'l Qual. 883-91 (1994).

"base flow," and it is what keeps streams from drying up during drier months. Base flow also helps keeps streams cool and dilutes pollution loads by creating sufficient flow. In coastal regions, this flow of fresh groundwater may help maintain a proper balance between fresh and saltwater in estuaries.[17] Drainage of any wetlands that recharge groundwater, whether isolated or not, can decrease this base flow to streams.[18]

In short, as this Court recognized in *Riverside Bayview Homes*, 474 U.S. at 133 (quoting legislative history), "'water moves in hydrologic cycles and it is essential that discharge of pollutants be controlled at the source.'" This principle applies equally to "isolated" ponds and wetlands and to "adjacent wetlands."

B. Ecological Functions of Isolated Ponds and Wetlands

Riverside Bayview Homes did not just rely on the hydrological relationships between adjacent wetlands and larger water bodies as a ground for defining "waters of the United States." It also recognized the importance of purely biological linkages. It noted that adjacent wetlands "serve significant natural biological functions, including food chain production, general habitat, and nesting, spawning, rearing and resting sites for aquatic . . . species." 474 U.S. at 134-35 (citations omitted).

Petitioner dismisses this form of linkage as secondary, but the Clean Water Act lists as its purposes the preservation not only of the "chemical" but also the "physical and biological integrity of the Nation's waters."

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[17] Council on Environmental Quality, *supra* note 8, at 103.

[18] *See generally* Winter, *et al.*, *supra* note 2, at 67. *See also* Loucks, *supra* note 5, at 56 (discussing how the drainage of depressional wetlands not only increased peak flows downstream but reduced downstream groundwater flows).

33 U.S.C. Sec. 1251(a). This Court has recognized this goal as "a condition in which the natural structure and function of ecosystems is maintained." *Riverside Bayview Homes*, 474 at 132. This Court has relied on this language not only in *Riverside Bayview Homes* but also in other cases to interpret the meaning of terms in the Act. For example, in *PUD No. 1 v. Washington Department of Ecology*, 511 U.S. 700, 714 (1994), this Court upheld the establishment of minimum flow limits below a dam under Section 401 of the Clean Water Act because it directly "reflects the Clean Water Act's goal of maintaining the 'chemical, physical and biological integrity of the Nation's waters.' " The Court noted that even the word "pollution" is defined to include not just chemical alterations of water but the "man induced alteration of the . . . physical [and] biological . . . integrity of water."

"Isolated" ponds, lakes, and wetlands do not just provide more habitat of the same type provided by other water bodies. Their habitat functions are in many cases distinct. Moreover, these distinct functions are interrelated with the functions of the other water bodies. Just as there are hydrological cycles, there are also biological cycles, and many aquatic animals use isolated water bodies for critical stages of their lives even while depending on flowing water bodies at other times.

Ducks and geese as a whole are particularly dependent on isolated wetlands. Part of the reason is that isolated wetlands provide seasonal oases of wet habitat in the relatively arid portions of the United States. Waterfowl need a combination of wintering habitats in the southern United States or central America, migratory "stopover" habitats in the central United States, and breeding habitats in the north. Their migrations are timed to the weeks when snow melt and spring rains form depressional wetland ponds in what are otherwise relatively dry landscapes.

Isolated wetlands and ponds also provide a valuable diversity of habitat for the simple reason that the water levels of isolated wetlands can be unrelated to those of nearby rivers - they can be wet when rivers are dry or visa versa. Shallow, isolated wetlands also tend to thaw earlier in spring than larger, more connected wetlands. These conditions allow early arriving waterfowl and other birds to feed on the insects and other invertebrates produced in these wetlands, which in turn enables them to build critical fat reserves necessary for successful nesting.[19]

Specific complexes of isolated ponds and wetlands therefore provide many of the most important habitats for waterfowl in the United States. One of the major wintering habitats in the United States consists of so-called playa lakes of the southern High Plains, including parts of New Mexico and Texas. Approximately 20,000 to 30,000 separate basins, covering 250,000 acres, provide winter habitat for approximately one million waterbirds, including ducks, geese, and cranes.[20]

The isolated wetlands and ponds of the Nebraska Rainwater Basin provide one of this country's important migratory habitats for waterfowl and many other species of waterbirds. Although most of these basins have been drained, the Rainwater Basin still consists of thousands of "isolated" wetland ponds in an area south of Nebraska's Platte River. These ponds form in depressions, within what was once prairie but is now farm fields, when they collect the melting snow around them. Although they may be inundated only through the early spring migration period,

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19 National Research Council of the National Academy of Sciences, Wetlands: Characteristics and Boundaries 156 (1995).

20 E.G. Bolen, *Playa Wetlands of the U.S. Southern High Plains: Their Values and Challenges for Management*, in B. Gopal (ed), Wetlands: Ecology and Management (1982).

between two and three million migratory waterfowl and a huge variety of shorebirds and wading birds use them, often for several weeks, as a rest and refueling stop on their northward migration precisely during this period. Some species are particularly dependent on these ponds, including 90% of the entire population of white-fronted geese and 50% of the mallards that use the mid-continental flyway.[21]

Moreover, the Rainwater Basin highlights the linkages between isolated water bodies and rivers. During the early weeks of spring migration, waterfowl move freely between the Platte and the marshes of the basin. And while the isolated wetlands meet the primary habitat and nutritional demands of waterfowl, the Platte probably serves as a "release valve" that migrating birds can rely on when the shallow basins are dry or locked in ice.[22]

The prairie pothole area is arguably the most important breeding habitat in North America for waterfowl. At least fifteen species of ducks nest in these potholes, including an estimated 70 to 90 percent of the continent's mallards (the most populous species), pintails, and canvasbacks. By some estimates, 50% of the total annual production of ducks comes from the potholes.[23] The ducks rely on all the

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21 Council on Environmental Quality, *supra*, note 8; G.L. Krapu, H.J. Reinecke, D.G. Jorde, and S.G. Simpson, *Spring Staging Ecology of Midcontinent Greater White-fronted Geese*, 59 J. Wildlife Management 736-746 (1995).

22 Jon Farrar, Nebraska Game & Parks Commission, Nebraska's Rainwater Basin (1996).

23 Thomas E. Dahl, Status of Prairie Pothole Wetlands in the United States (U.S. Fish & Wildlife Service 1990); H.A. Kantrud, G.L. Krapu & G.A. Swanson, Prairie Basin Wetlands of the Dakotas: A Community Profile, U.S. Fish & Wildlife Service Biological Report 85, at 15 (1989) (prairie pothole region, comprising only 10% of the waterfowl breeding area of the continent, produces 50% of North American ducks in an average year and more when water conditions are good).

different sizes of isolated wetlands, typically using different kinds of basins as the spring and summer progress.

Although Petitioner states that the connection between isolated wetlands and their effects on bird populations and therefore the recreational use of birds is attenuated, the connection is among the most well known in ecology. As early as 1969, a high correlation was demonstrated between the availability of isolated ponds in the prairie pothole area of North America in July and the size of the subsequent year's duck population.[24] A recent paper has shown that the risk of mallard nesting failure is eleven times higher when dry years in the prairie potholes reduce the acreage of seasonal, isolated wetlands.[25]

Ducks and geese, of course, also spend time along navigable rivers and coastal waters. But many of these birds were hatched in isolated ponds and wetlands by parents who also relied on isolated ponds and wetlands to build fat reserves needed for successful nesting. Mallards, for example, winter in large numbers along the major bottomland river systems of the south.[26] And canvasback ducks, whose annual migrations provide one of the great

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[24] W.F. Crissey, *Prairie Potholes from a Continental Viewpoint*, in Saskatoon Wetlands Seminar, Canadian Wildlife Service Report Series 6, 161-71 (1969).

[25] G.L. Krapu, P.J. Pietz, D.A. Brandt & R.R. Cox, Jr., *Factors Affecting Mallard Brood Survival in Prairie Pothole Landscapes*, 64 J. Wildlife Management 553-61 (2000).

[26] K.J. Reinecke, R.C. Barkley & C.K. Baxter, *Potential Effects of Changing Water Conditions on Mallards Wintering in the Mississippi Alluvial Valley*, in Waterfowl in Winter, Milton W. Weller (ed), 325-36 (1988).

sights on the wildlife refuges of the Upper Mississippi River, also breed primarily in prairie potholes.[27]

Ducks and geese therefore illustrate the important ecological relationship between isolated wetlands and ponds, and navigable water bodies. But other waterbirds also use both kinds of water bodies at different parts of their life cycles. Examples include sandhill cranes, which spend critical weeks each spring fattening on the Platte River in Nebraska, but that winter in large numbers on isolated lakes in West Texas,[28] and shorebirds such as the piping plover, which winters in coastal areas and uses sandbars in major rivers for some nesting, but also relies heavily on isolated lakes in the Prairie Pothole Region.[29]

While less visible than waterfowl and wading birds, amphibians and reptiles – including frogs, salamanders, snakes, and turtles – also play an important role in aquatic ecosystems that is illustrated by their sheer collective weight. In some ecosystems, they comprise a majority of the total living mass of vertebrate animals, and thus form an

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[27] *Compare* R.E. Stewart & H.A. Kantrud, *Ecological Distribution of Breeding Waterfowl Populations in North Dakota*, 37 J. Wildlife. Management 39-50 (1973) (discussing canvasback use of prairie potholes) *with* C.E. Korschgen, L.S. George & W.L. Green, *Feeding Ecology of Canvasbacks Staging on Pool 7 of the Upper Mississippi River*, in Weller, *supra* note 26, at 237-249.

[28] G.L. Krapu, G.C. Iverson, K.J. Reinecke & C.M. Boise, *Fat Deposition and Arctic-Nesting Sandhill Cranes*, 102 Auk 362-68 (discussing importance of growth in fat reserves at Platte River staging); T.C. Tacha, S.A. Nesbitt & P.A. Vohs, *Sandhill Crane*, in Migratory Shore and Upland Game Bird Management in North America 77-94 (1994) (discussing wintering on shallow saline lakes in West Texas).

[29] S.P. Elias, J.D. Fraser & P.A. Buckley, *Piping Plover Foraging Ecology in New York Barrier Islands*, 64 J. Wildlife Management 346-54 (2000).

important part of the food chain, eating insects and plants and, in turn, being eaten by fish and waterfowl.[30]

Amphibians as a whole rely heavily on isolated, often seasonal, wetland ponds for breeding or feeding sites. Many species prefer isolated ponds precisely because they harbor fewer predators such as fish that eat amphibian eggs and larvae.[31] For example, out of thirty-four species of amphibians at a highly-studied site in South Carolina, sixteen species depend on temporary wetlands for breeding.[32] This percentage is probably typical of amphibians generally.[33]

In addition to their value as breeding sites, isolated ponds also provide critical "ecological connectivity" for

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[30] Although amphibians are difficult to study, one major study site in the United States is Hubbard Brook, New Hampshire, where scientists have estimated that salamanders alone account for more than half of the total vertebrate biomass. T.M. Burton and G.E. Likens, *Salamander Populations and Biomass in the Hubbard Brook Experimental Forest, New Hampshire*," Copeia 541-546 (1975); T.M. Burton & G.E. Likens, *Energy Flow and Nutrient Cycling in Salamander Populations in the Hubbard Brook Experimental Forest, New Hampshire*, 56 Ecology 1068-1080 (1975).

[31] R.D. Semlitsch & J.R. Bodie, *Are Small, Isolated Wetlands Expendable?*, 12 Conservation Biology 1129-1133 (1998). For examples of studies showing the importance of isolated ponds and wetlands, see D.K. Skelly, E.E. Werner & S.A. Cortwright, *Long-term Distributional Dynamics of a Michigan Amphibian Assemblage*, 80 Ecology 2326-2337 (1999); D.K. Skelly, *Pond Drying, Predators, and the Distribution of Pseudacris Tadpoles*, Copeia 599-605 (1996); R.D. Semlitsch, *Allotopic Distribution of Two Salamanders: Effects of Fish Predation and Competitive Interactions*, Copeia 290-298 (1988).

[32] J. Whitfield Gibbons & Raymond D. Semlitsch, Guide to Amphibians and Reptiles of the Savannah River Site (1991).

[33] Roger Conant & Joseph T. Collins, A Field Guide to Reptiles and Amphibians: Eastern and Central North America (1991).

many amphibians. Changing conditions in water bodies can cause local species to become extinct, so the long-term presence of amphibians depends on the ability of other amphibians to recolonize sites after extinction. But individual amphibians have limited abilities to migrate long distances, often travelling less than one kilometer. Habitats must therefore be close enough together to allow successful migration among sites. Small isolated wetlands provide a sufficient density of aquatic habitat in some areas to allow amphibians to migrate and recolonize lost sites.[34]

Because they are themselves a food source for migratory waterfowl and wading birds, amphibians play an important function in the national aquatic system. But like many waterbirds, many amphibians that rely at some part of their life cycles on isolated ponds also use permanent streams and rivers at other seasons or parts of their life cycle, often as winter habitat.[35] Several recent studies of turtles highlight these interactions. A detailed study on the floodplain of the Missouri River demonstrated that turtles of several of the most abundant species, especially juveniles, use flooded temporary wetlands for feeding during the summer months and then migrate to a nearby river to spend the winter in deep protected waters.[36] Other species of

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[34] Semlitsch & Bodie, *supra* at note 31; *see also* J.P. Gibbs, *Wetland Loss and Biodiversity Conservation*, 14 Conservation Biology 314-317 (2000) (calculating how loss of some isolated wetlands can eliminate conditions for survival of amphibians in others).

[35] V.S. Lamoureux & D.M. Madison, *Overwintering Habitats of Radio-implanted Green Frogs, Rana clamitans*, 33 J. of Herpetology 430-435 (1999).

[36] J.R. Bodie & R.D.Semlitsch, *Spatial and Temporal Use of Floodplain Habitats by Lentic and Lotic Species of Aquatic Turtles*, 122 Oecologia 138-146 (2000).

turtles use more permanent aquatic habitats during droughts and small, isolated ponds during wet conditions.[37]

All of these conditions highlight a simple fact: Isolated water bodies are critical to the overall biological integrity of the nation's waters.

C. Practical Considerations

Petitioner asks this Court to ignore the close biological links between isolated ponds and wetlands and navigable waters largely on the grounds that regulation on that basis could lead to practical results it considers undesirable. It variously phrases these results as regulation of "seasonally wet areas in homeowners' backyards" or regulation of "any miniscule body of water capable of attracting a migrating duck." It also considers this result unconstitutional on the ground that the regulation of isolated waters puts the federal government into the business of local land use regulation.

In weighing these practical arguments, this Court may wish to consider factual information about the prevalence and importance of isolated wetlands. Petitioner accepts that regulation all streams and adjacent wetlands tributary to navigable waters is permissible under the Clean Water Act and under the Constitution. Although no precise estimate is available, it is the view of the scientists on this brief that probably no more than 20% of the roughly 100 million acres of wetlands in the contiguous United States could be

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[37] K.R. Matthews & K.L. Pope, *A Telemetric Study of the Movement Patterns and Habitat Use of Rana muscosa, the Mountain Yellow-legged Frog, in a High-elevation Basin in Kings Canyon National Park, California*, 33 J. of Herpetology 615-624 (1999); T.E. Graham, *Habitat Use and Population Parameters of the Spotted Turtle, Clemmys guttata, a Species of Special Concern in Massachusetts*, 1 Chelonian Conservation Biology 207-214 (1995); D. Moll, *Population Sizes and Foraging Ecology in a Tropical Freshwater Stream Turtle Community*, 24 J. of Herpetology 48-53 (1990).

characterized as isolated.[38] This means that protection of isolated wetlands constitutes roughly 1% of the total land in the contiguous 48 states (roughly two billion acres), compared to the roughly 4% of the country occupied by other wetlands that Petitioner agrees are appropriately waters of the United States. It is not clear therefore why regulation of isolated water bodies takes the regulatory program into an area unlike that which Petitioner already finds acceptable.

And while it is possible that isolated wetlands and ponds can be found in backyards – just as small streams and the surrounding wetlands are found in backyards – that does not mean that every wet spot can be regulated as a water body. To be protected, an area must also constitute a water body and must therefore meet wetness criteria. The water bodies at issue in this case are relatively deep ponds, but at the drier end of the spectrum of wetlands, where the criteria normally require that water be present long enough to result in a predominance of vegetation adapted to at least saturated soil conditions. *Riverside Bayview Homes*, 474 U.S. at 124-25. In other words, the mere fact that a duck uses a damp spot does not automatically make it a regulated water body.

On the other hand, protection of the biological integrity of the nation's aquatic ecosystems is simply not possible

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[38] For estimated total wetland acreage in the contiguous 48 states, see Council of Environmental Quality, *supra* note 8, at 100 (putting estimate at 95 million acres). We have been unable to find any documented estimate of the percentage of wetland or pond acres that are isolated probably because "isolated" is largely a matter of degree and because scientists do not consider this term to be particularly useful in distinguishing different wetland functions. Despite this lack of a clear estimate, there is a general consensus among wetland scientists that isolated wetlands are unlikely to exceed 20% of the total acreage of wetlands.

without protection of isolated lakes, ponds, and wetlands. This is true not only because of their ecological linkages to navigable waters discussed above, but also because isolated water bodies (while a modest minority of wetlands nationally) can form much of the entire aquatic ecosystem in critical areas. While officials in Illinois recently estimated, in preparation for this case, that only around 15% of all wetlands remaining in the state are "isolated,"[39] prairie potholes comprise 93% of the total water/wetland surface area in the prairie pothole area of North Dakota, a majority of the state's territory.[40] Moreover, wetlands in North Dakota hold the vast majority of the state's surface storage apart from that provided by two man-made reservoirs.[41]

Moreover, while Petitioner focuses attention on backyards, Petitioner's statutory theory would exclude not merely isolated wetlands, but large isolated lakes as well because they too do not flow by surface water into navigable water bodies. There are more than 22 million acres of lakes in the United States, including 100,000 lakes

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[39] The Illinois Department of Natural Resources has estimated that isolated wetlands in Illinois comprise roughly 12% of the wetland acreage. *See* Memo from Ryan Taylor, Illinois Department of Natural Resources to Marvin Hubbell, Illinois Department of Natural Resources Regarding "Isolated Wetlands Analysis," (Sept. 18, 2000). This estimate may be an overestimate, however, since the analysis combined both truly isolated wetlands and those wetlands adjacent to small, headwater streams.

[40] Daniel E. Hubbard, Glaciated Prairie Wetland Functions and Values: A Synthesis of the Literature, U.S. Fish & Wildlife Service Biological Report 7 (1988); for a map showing the portion of North Dakota in the prairie pothole region, see *id*. at 2.

[41] D. Ripley, *An Overview of North Dakota's Water Resources*, in North Dakota Water Quality Symposium (North Dakota State Extension Service March 20-21, 1990).

with more than 100 acres.[42] An unknown number of these lakes are "isolated," but isolated lakes can be very large, including Utah Lake and Lake Tahoe in California and Nevada.

In these landscapes in particular, isolated water bodies are not merely important because of their relationships to other water bodies; they are relied upon for all of the basic functions that may elsewhere be served by rivers and connected lakes. Both large isolated lakes and smaller isolated ponds are used for fishing (isolated wetlands are a major source of the country's bait fish).[43] They may also serve as an important source of drinking water for cattle and irrigation water for crops.[44] Perhaps most important, many isolated wetlands are a major source of groundwater recharge, including recharge for major aquifers like the Ogallala[45] – a function that can be lost or greatly reduced if the water is drained into streams.

Petitioner's theory of the Clean Water Act would preclude protection of all isolated water bodies because of

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[42] National Research Council of the National Academy of Sciences, Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy 89 (1992).

[43] *See* Utah v. Marsh, 740 F.2d 799, 803 (10th Cir. 1984) (noting that Utah Lake supported "the State's most valuable water fishery which markets most of the catch out of state"); Hubbard, *supra* note 40, at 30 (prairie pothole wetlands are important to the commercial baitfish industry).

[44] *See* Utah v. Marsh, 740 F.2d at 803; H.A. Kantrud, *supra* note 23, at 33 (prairie potholes used to graze cattle, sheep, and horses); E.G. Bolen, L.M. Smith & H.L. Schramm, Jr., *Prairie Wetlands of the Southern High Plains*," 39 BioScience 615-23, 619 (playa lakes are used for irrigation and grazing).

[45] Carter, *supra* note 4, at 44 (playa lakes in West Texas and New Mexico are major source of recharge to Ogallala aquifer).

their lack of relationship to navigable waters, and it would do so not merely under Section 404 of the Clean Water Act but also under Section 402, which regulates the discharge of waste. See discussion, *supra*. Petitioner would therefore even bar regulation of sewage or industrial discharges into lakes as large as Utah Lake.

The purposes of the Clean Water Act, to preserve the "chemical, physical and biological integrity of the nation's waters," appear to have little to do with navigation. In general, this Court has frequently held that the "object" of statutes "is the surest guide to their meaning." *Watt v. Alaska*, 451 U.S. 259, 266 n. 9 (1981) (citations omitted) and that an agency interpretation that "frustrate[s] the policy that Congress sought to implement" is unreasonable. *Federal Election Commission v. Democratic Senatorial Campaign Committee*, 454 U.S. 27, 32 (1981). It would not be possible to protect the integrity of the nation's waters without equally addressing isolated lakes, ponds, and wetlands.

D. The Ecological and Hydrologic Relationship Between the Balefill Site and the Broader Aquatic Ecosystem

Although presented to this Court as a case solely concerned with the protection of migratory birds, this case actually encompasses the broad hydrological and biological functions of isolated water bodies. The Corps of Engineers needs a simple jurisdictional test for waters of the United States because many functions of water bodies or potential harm from their loss or pollution only become evident after the analysis undertaken through the permit process. The Corps therefore asserted jurisdiction in this case because of use by migratory birds. But the final decision denying the permit found many potential environmental impacts that the Corps could presumably also have used to identify connections to commerce. This case therefore illustrates

why it is appropriate that threshold jurisdictional tests, whether statutory or constitutional, should focus on the likely functions of water bodies as a group.

According to one of the reports submitted by SWANCC, the site contains twenty-one acres of ponds ranging from six feet to thirteen feet in depth. Inventory of Fish at the SWANCC Balefile Site, A.R. 40313-15. SWANCC's expert collected ten species of fish, including such sportfish as largemouth bass, bluegill, carp, and grass pickerel, and noted that a sport fishery existed on the site. *Id*. The site contains salamanders, toads, frogs, and turtles that breed in the isolated ponds. Inventory of Herpetofauna at the SWANCC Balefill Site, A.R. 40401-03. The site also contains an exceptionally diverse variety of bird species, with at least 128 species. Fish & Wildlife Coordination Act Report, A.R. 16383. Perhaps most important, the site contains what the U.S. Fish & Wildlife Service (FWS) called the second largest heron rookery in northern Illinois with more than 130 birds, 15% of the region's herons. A.R. 16386-88. Great blue heron rookery sites are rare because herons nest primarily in locations that can support many birds with a combination of high trees for nesting, and abundant shallow waters and saturated wetland soils to produce sufficient food – such as the amphibians – for adult herons and their young.

According to the U.S. Fish & Wildlife Service, these biological riches are "due to the complex interspersion of habitat features, including semi-permanent ponds, saturated soils, drainageways, and ridge crests." Department of the Army Permit Evaluation and Decision Document, A.R. 15582 (summarizing comments of FWS). In other words, this site illustrates why aquatic animals rely on a diversity of aquatic habitats, including isolated wetlands. And the fact that great blue herons are spectacular inhabitants also of large rivers and wetlands such as the Everglades highlights

the ecological interdependence between the ecology of those systems and isolated wetlands and ponds.[46]

The site also illustrates the hydrologic significance of isolated isolated water bodies. It holds enough water to fill the Pentagon four feet deep. Faced with a proposal to fill it with a landfill, an obvious question to any hydrologist is where will the water go that is now captured by the site. Any development needs a stormwater management plan for rainfall, but developing water bodies usually makes the potential impacts greater because it displaces a storage area. Absent strict controls, this water could easily end up directly or indirectly in the Fox River, less than two miles from the site, which in turn flows into the navigable Illinois and Mississippi Rivers.

To address this question, SWANCC's application included a Stormwater Management Plan. It promised large detention basins designed to capture almost all the runoff from huge storms, but it still proposed to bypass some flows into a ditch flowing offsite to the north. Stormwater Management Plan, A.R. 219-26. The record does not reveal where the ditch eventually flows. But the Corps ultimately denied the permit in part because it believed that "stormwater volumes and associated sediment coming off the landfill could be significantly larger" than that described by SWANCC. Decision Document, A.R. 15645-15647. Faced with what it considered faulty calculations, the Corps never bothered to analyze the potential downstream effects.

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[46] *See* Paul Ehrlich, David S. Dobkin & Darryl Wheye, The Birder's Handbook: A Field Guide to the Natural History of North American Birds 42 (1988); Wayne Huffman, G. Thomas Bancroft & Richard J. Sawicki, *Relationships Among Wading Bird Foraging Patterns, Colony Locations, and Hydrology in the Everglades*, in Steve M. Davis & John C. Ogden, Everglades: The Ecosystem and its Restoration 585-614, at 593 & 596 (1994).

Whether the Corps was correct or not, this case illustrates one of the hydrologic reasons to regulate the filling of "isolated" waters: The water has to go somewhere, and that creates a serious potential for downstream water quantity and pollution problems.

Another obvious concern presented by siting a landfill in a pond is the threat of contamination because it increases the likelihood that water will come into contact with waste material. As the Corps stated in its permit decision, "We believe that the site conditions of the proposed project do not provide the best landfill siting conditions because of the projects [sic] close proximity to potable groundwater supplies." A.R. 15652 In this case, a primary concern of the permitting process was whether the landfill would in the long run contaminate the Newark Aquifer, a major drinking water source for thousands of people. A.R.15653. The Corps of Engineers acknowledged that "heroic" engineering efforts, combined with long-term monitoring and control of landfill "leachate" could protect the aquifer. But the Corps found that SWANCC had not made proper financial allowance for the long-term maintenance of the site, and it considered the risks ultimately unacceptable in light of other good waste disposal options. Decision Document at 15649-53. Even if the permit had been granted with the conditions proposed by SWANCC, this case would still illustrate the role of the permit to address the potential effects of discharging pollutants into isolated water bodies.

Petitioner repeatedly asks this Court to think about the miniscule damp spot in the backyard. But the precise question in this case is whether the federal government has the authority to regulate the construction of a landfill on twenty-one acres of ponds as much as thirteen feet deep that support a recreational fishery and a huge rookery for migrating great blue herons, and under conditions that

threaten off-site flooding, and contamination of drinking water supplies for thousands of people.

CONCLUSION

For the foregoing reasons, amici urge this Court to conclude that the regulation of discharges into isolated ponds and wetlands in general and in this case is authorized by the Clean Water Act and the Commerce Clause of the U.S. Constitution.

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APPENDIX

APPENDIX A

BRIEF BIOGRAPHIES

Dr. Gene Likens is President and Director of the Institute for Ecosystem Studies, Vice President of the New York Botanical Garden, Director of the Mary Flagler Arboretum, and Professor of Biology at Yale University. A member of the National Academy of Sciences and Past President of the Ecological Society of America, he has been awarded nine honorary degrees from universities around the world, among numerous international professional awards. His more than 400 articles and 14 books explore a wide range of ecological fields with a particular emphasis on biogeochemistry.

Dr. Joy Zedler is Aldo Leopold Chair of Restoration Ecology at the University of Wisconsin and a former member of the National Academy of Science's Water Science and Technology Board. She is presently chairing a panel of the National Academy of Sciences studying wetland mitigation and previously served on panels that analyzed wetland identification and classification and restoration of aquatic ecosystems.

Dr. Bill Mitsch is Professor of Natural Resources and Environmental Science at Ohio State University. The coauthor of the leading textbook on wetlands among a large number of other publications, he is the editor-in-chief of Ecological Engineering and chaired the 1992 INTECOL conference on wetlands. He served on a panel established by the National Academy of Sciences to advise Congress on wetland identification and classification, and is presently serving on a panel to evaluate wetland mitigation.

Dr. Rebecca R. Sharitz is a Professor of Botany at the University of Georgia and a Senior Research Ecologist at the Savannah River Ecology Laboratory, where she previously served as director. She serves as Secretary General of the International Association of Ecology, and has served on National Academy of Sciences' panels regarding restoration of aquatic ecosystems and restoration of the Everglades system.

Dr. Joseph Larson, Professor Emeritus of the University of Massachusetts, developed the first models for functional assessment of freshwater wetlands and for predicting wildlife species habitat in New England freshwater wetlands. He has been a U.S. delegate to the meetings of the contracting nations under the RAMSAR treaty on wetlands of international importance. He was awarded the national Chevron Conservation Award for his work on wetlands and was the founding Executive Chairman of the National Wetlands Technical Council.

Dr. Leigh H. Fredrickson is Rucker Professor of Fisheries and Wildlife at the University of Missouri and Director of Gaylord Memorial Laboratory. He is the author of innumerable articles and books on waterfowl, waterbirds, and wetlands, and is considered by many the dean of American waterfowl scientists.

Dr. Mark Brinson is Professor of Biology at East Carolina University and is a leading expert on the cycling of nitrogen, phosphorus, and carbon in wetlands. He served on National Academy of Sciences panel to evaluate wetland identification and classification.

Dr. Orie Loucks is Ohio Eminent Scholar in Applied Ecosystem Studies and Professor of Zoology at Miami University of Ohio. The author of more than 200 scientific publications, he served ten years on the National Academy of Science's Board on Water Science and Technology, and also on the Science Advisory Board of the International Joint Commission, and the Board of Governors of The Nature Conservancy. He is an elected Fellow of the Ohio Academy of Sciences and the American Association for the Advancement of Science, and was given the Distinguished Service Award of the American Institute for Biological Sciences in 1994.

Dr. Stuart Pimm is Professor of Conservation Biology at the Center for Environmental Research and Conservation at Columbia University. His awards include a Pew Fellowship in Conservation and the Environment, and the Kempe Prize for Distinguished Ecologist. He is author of roughly 200 published papers and three books, including the widely aclaimed The Balance of Nature.

Dr. Raymond Semlitsch is Professor of Biology at the University of Missouri. One of this country's leading experts on amphibians, he has published more than 100 articles, including many of the leading papers on the use of isolated wetlands by amphibians.

Dr. Curtis Bohlen is Assistant Professor of Environmental Studies at Bates College and a former researcher of the Center for Environmental and Estuarine Studies of the University of Maryland. An ecologist, he has published more than a dozen articles and reports on wetland science and policy.

Dr. Christopher Woltemade is Associate Professor of Geography at Pennsylvania State University at Shippensburg. A hydrogeomorphologist, his published work has examined watershed influences on flood flows, wetland capability to improve water quality, and the relationship between river management and wetland quality.

Dr. Michael Hirshfield is currently Vice President for Resource Protection at the Chesapeake Bay Foundation, and previously served as Director of the Chesapeake Bay Research and Monitoring Division for the State of Maryland and Director of the Academy of Natural Sciences of Philadelphia's Estuarine Research Laboratory in Benedict, Maryland. He received his Ph.D. in Zoology from the University of Michigan in 1977.

Dr. John Callaway is an Assistant Professor in the Department of Environmental Science at the University of San Francisco and served as Associate Director of the Pacific Estuarine Research Laboratory at San Diego State University. He has published many articles regarding the restoration of wetland soils and plants and their sediment dynamics.

Dr. Terry Huffman, a botanist by training, was a primary author of the manual used by the federal government to identify wetlands and is the author of many publications on wetlands.

Dr. G. Thomas Bancroft is Vice President of the Ecology and Economics Research Department of the Wilderness Society, and the former Director of the MacArthur Agro-ecology Research Center in Florida . He has published numerous articles on migratory water birds with a particular

emphasis on wading bird use of the Greater Everglades ecosystem.

Dr. Klaus O. Richter is the Senior Wetland Ecologist in King County's Department of Natural Resources in Washington State. For the past 15 years Dr. Richter has specialized in freshwater wetland science, management, protection, and regulation. A recipient of the 1996 National Wetlands Award in Science Research sponsored by the Environmental Law Institute and the US Environmental Protection Agency, Klaus has authored numerous scientific papers on the monitoring, distribution, and decline of amphibians, particularly near Puget Sound.

Dr. John M. Teal is a Senior Emeritus at Woods Hole Oceanographic Institution and past president of the Society of Wetland Scientists. He is a recipient of the National Wetlands Award for Science Research from the Environmental Law Institute, US Environmental Protection Agency, US Fish & Wildlife Service, and National Marine Fisheries Service, and the 1999 Odum Award from The Estuarine Research Federation. The author of over 140 scientific publications, his 1969 book, Life and Death of a Salt Marsh, played a major role in increasing public awareness of the importance of wetlands.